

EWF Special Course

EUROPEAN MANUAL METAL ARC (MMA)-DIVER-WELDER



Minimum Requirements for the Education, Training, Examination and Qualification





MINIMUM REQUIREMENTS FOR THE EDUCATION, TRAINING, EXAMINATION AND QUALIFICATION

EWF Special Course

EUROPEAN MANUAL METAL ARC (MMA) - DIVER WELDER EW-UW

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Minimum requirements for the education, examination and qualification of European Manual Metal Arc (MMA)-Diver-Welder

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Foreword

The use of this guideline is restricted to organizations approved by the Authorized National Body (ANB).

The section I of this guideline covers the minimum requirements for education and training.

The section II of this guideline covers the examination and qualification:

Section I: Minimum requirements for education and training

1 Introduction

This guideline for the European education and training of diver-welders for hyperbaric wet MMA-welding according to EN ISO 4063 has been advised and formulated by members of the Committee for Education and Training of the EWF. It is designed to provide a harmonized scheme for a comprehensive education and training of diver-welders.

The International Standard EN ISO 15618-1 provides a scheme for diver-welder tests, to evaluate and to certify the capability of a diver-welder for a limited range of welding conditions. It serves for quality assurance for a specific job, and provides an education program based on experience, in which steps and sequence a high skill in welding can be acquired. Only highly qualified diver-welders are able to improve the credibility of the wet welding process, and to achieve the acceptance of the classifying authorities.

This guideline provides a combination of high skill, assessed by tests of increasing difficulty, including EN ISO 9606-1 and the necessary theoretical background, assessed by theoretical examinations. Diver-welders successfully completing this program achieve a high standard of qualification and skill, which enables them to perform the wet welding process of the required quality.

Figure 1 gives an overview on the modules available.

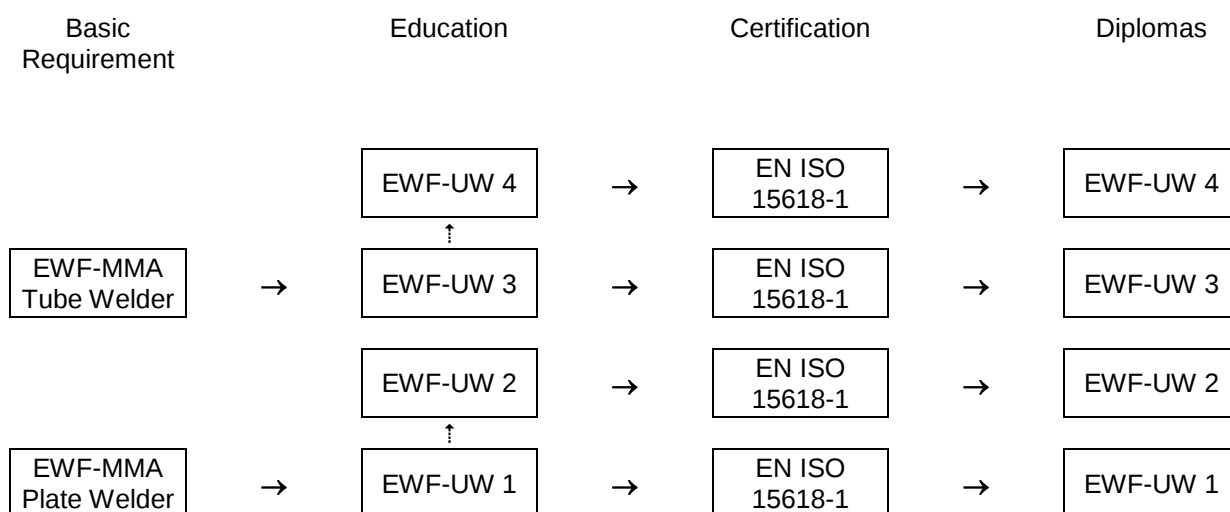


Figure 1: Use of the modules

2 Access to the course

Normal physical and mental capability is assumed. Basic skill according to the following requirements is essential. Course attenders and teachers shall have a good command of a common language, so that they can successfully participate in instruction, and take part in theoretical and verbal tests.

For a successful participation in the diver-welder training course, the trainee has to give his full concentration on the training course and its requirements, as wet welding is one of the most difficult welding technologies. High weld quality is necessary to achieve the acceptance of wet welding of structural components from the authorities. Such a weld quality can only be achieved by full and non-disrupted concentration throughout the whole welding operation, and by excellent skill. The diver-welder has to identify himself with the task he has to perform. Therefore only well trained and experienced commercial divers should participate in such a diver-welder training course. It is an essential requirement that the trainee has to prove his diver qualification. This can be done by an approved certificate issued by a recognized authority.

The trainee has to prove his ability to weld satisfactorily under atmospheric conditions (e.g. by a diploma as an EWF-MMA welder, to have the necessary background on basic welding technology, materials structure, consumables, heat transfer safety requirements etc.). He shall have good experience and skill in practical welding under atmospheric conditions.

For participation in the theoretical and practical examination according to EN ISO 15618-1 a successful participation in this diver-welder training course is essential.

3 Curriculum of training

The diver-welder training course breaks down into practical and theoretical instruction. The training practice (welding and qualification) is based on relevant instructions and exercise schedules (see tables 3 to 6 as well as EN ISO 15618-1, figures 1 to 7 for the shape and dimension of test pieces).

The type of base material on which wet welding is usually applied will be unalloyed or low alloyed structural steel, corresponding to material group 1 according CR ISO/TR 15608. Suggested material dimensions are shown in tables 3 to 6. However, the range of thickness can be chosen to suit production requirements. The type of materials and electrodes used in the training should be similar to those to be used in the examination test pieces.

The periods of time given in the tables 3 to 6 represent the average time required to attain the expected level of skill. The time needed may vary individually, according to the capability of the trainee. For each individual training module, it is at the discretion of the teaching staff to establish the sequence and number of exercises.

The theoretical instruction given to the trainees aims to give a basic understanding of the wet welding process and the behavior of the materials in respect of the rapid cooling rate, hydrogen contamination, porosity and cracking problems, including standards and safety regulations. The themes and keywords are given under the modules descriptions. Reference to appropriate national/international standards, directives and regulations should be made throughout the course.

A "teaching hour" will contain at least 50 minutes of direct teaching time. After each module a practical and theoretical examination is performed. The test pieces to be welded are given under the description of each module, in correspondence to a WPS, the general rules for examination are given in section II of document EWF 001-416a.

As wet welding is one of the most difficult welding procedure, the instructor for practical welding (diver-welder-instructor) is required to be at the site with the diver-welder trainee, and give him active support and guidance for the process handling, electrode positioning, arc control, arc judgement, adjustment of electrical settings on the power source, droplet transfer and bead appearance etc., throughout the whole period of the course.

As the training course is very exhausting for the trainee, one training sequence of constant practice in water should not exceed more than three hours per sequence. After one training sequence in water the trainee should be given sufficient time for recovery.

From practical experience, one trainer shall not supervise more than five trainees working in the water depending on the facilities of the training schools.

4 Theoretical education and practical training

The full EWF course for wet MMA-Welding consists of modules EWF-E-UW 1 to EWF-E-UW 4 for practical training, and of the instruction units EWF-UW 6.1 and EWF-E-UW 6.2 for the theoretical education.

4.1 Theoretical education

4.1.1 General

The content is given in the table 1.

Table 1: Theoretical education — Hours

Code	Part	hours
A	EWF-E-UW 6.1 Repetition Part	6 h
B	EWF-E-UW 6.2 Underwater Welding Part	8 h
		Σ 14 h

It is not obligatory to follow exactly the order of the topics given in this guideline and choice in the arrangement of the syllabus is permitted.

The depth to which each topic is dealt with is indicated by the objectives and the number of hours allocated to it in the guideline. This will be reflected in the scope and depth of the examination to meet the required result.

**4.1.2 EWF-E-UW 6.1 Repetition Part (A)**

	Teaching hours
E-UW 6.1.1 <u>Welding Processes and their general differences</u>	1
E-UW 6.1.2 <u>Introduction to Electricity</u>	
Nature of electricity	
Generation	
Alternating and direct current	
Voltage, current, resistance	
Electric power	2
Heating effects	
Physiological effects	
Nature of the electric arc	
The arc as heat source	
Arc influencing factors	
E-UW 6.1.3 <u>Metallurgical Aspects</u>	
Microstructure of metals and possible failures	
Welding electrode design composition, standardization	2
Type of metal transfer, gap bridging, spattering	
Formation of the welded joint	
E-UW 6.1.4 <u>Examination of Welded Joints</u>	
Visual Examination	
NDT-Testing	1
Destructive Testing	
Simple test methods	
Types of Testing methods in wet application	
UW 6.1 Total	6

4.1.3 EWF-E-UW 6.2 Underwater Welding Part (B)

	Teaching hours
E-UW 6.2.1 <u>Materials for the Application of the Wet Welding Process</u>	
Types of steels and weldability	
- structural steels	
- stainless steels	
- carbon equivalent, Cr + Ni equivalent,	2
- Schaeffler diagram	
Types of electrodes for wet welding	
- design of electrodes and flux composition	
- applicability of electrodes	
- water protective coating	
E-UW 6.2.2 <u>Metallurgical Aspects in Wet Welding</u>	
Influence and compensation of surrounding medium on	
- Arc stability	
- Metal Transfer	
- Cooling rate	2
- Hydrogen contamination and porosity	
- Bead formation and appearance	
- Burn-off rate of alloying elements	
- Effect of increased depth	
- Arc stability	
- Weld quality	
E-UW 6.2.3 <u>Power Sources and Polarity</u>	
Type of power sources	1
Polarity in Welding process	
Welding set characteristic curves	
E-UW 6.2.4 <u>Health and Safety (in UW-application)</u>	
Eye hazards	
Electric shock	
Burns and fires	
Respiratory hazards	3
Basic personal protection	
Fume and gas control	
Prevention against explosions	
Application of Rules and Regulations (national and international)	
UW 6.2 - Total	8
Total Duration	14

4.2 Practical training

The aims of the practical training of all modules are given in table 2. Welding positions included in table 2 shall be used according to EN ISO 6947.

Table 2: Modules for the practical training

EWF-E-UW 4 Underwater Pipe Lap Welder Welding Position PG, J-L045 Recommendation: Minimum wall thickness 10 mm Tube diameter: 150 mm to 250 mm	practical: theoretical: <u>test*</u> : <u>total</u> :	45 h 14 h ** <u>6 h</u> <u>65 h</u>
EWF-E-UW 3 Underwater Pipe/Plate Fillet Welder Welding Position PG, PD Recommendation: Minimum wall thickness 10 mm Tube diameter: 150 mm to 250 mm	practical: theoretical: <u>test *</u> : <u>total</u> :	47 h 14 h ** <u>6 h</u> <u>67 h</u>
EWF-E-UW 2 Underwater Plate Lap Welder Welding positions: PG, PD Recommendation: Minimum plate thickness 10 mm Specimens may be selected according to figures 7a) or 7b) of EN ISO 15618-1	practical: theoretical: <u>test *</u> : <u>total</u> :	36 h 14 h ** <u>6 h</u> <u>56 h</u>
EWF-E-UW 1 Underwater Plate Fillet Welder Welding Position: PG, PD Recommendation: Minimum plate thickness 10 mm	practical: theoretical: <u>test *</u> : <u>total</u> :	37 h 14 h ** <u>6 h</u> <u>57 h</u>
* The set time for the tests includes practical and theoretical tests. ** In case the additional courses of EWF-E-UW 2 to EWF-E-UW 4 will be attended within 6 months after the previous one, the theoretical training of the next following course can be omitted.		

The average times for the test modules are quoted on a “stand-alone” basis. Where additional modules follow on from the initial module, the hours quoted can be reduced to represent the additional training and qualification requirements. This reduction in hours is only applicable where the initial qualification module took place within the preceding six months, and the welder has carried out welding on a regular basis (according to EN ISO 15618-1) during this period, in accordance with the initial qualification.

Details for the practical exercises are given in the tables 3 to 6. Welding positions included in the tables 3 to 6 shall be used according to EN ISO 6947.

Table 3: Practical exercises — EWF-E-UW 1

EFW-E-UW 1			Practical Exercises				
No	minimum time		Exercise				
	hours	total hours	type of weld	recommended thickness range (mm)	position	sketch	electrode (Ø in mm)
1	2	2	—	1)			
2	6	6 + 2 = 8	bead on plate welding	10	PA		3,2
3	9,5	8 + 9,5 = 17,5	fillet weld T-joint	10	PB		3,2
4	9,5 (+ 3,5)	17,5 + 9,5 + 3,5 = 30,5	fillet weld T-joint	10	PG		3,2
5	9,5 (+ 3,5)	30,5 + 9,5 + 3,5 = 43,5	fillet weld T-joint	10	PD		3,2
6	15	43,5 + 15 = 58,5	—	2)			

1) introduction / familiarization
2) theoretical education E-UW 1.2

Table 4: Practical exercises — EWF-E-UW 2

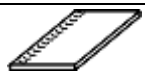
EWF-E-UW 2			Practical Exercises				
No	minimum time		Exercise				
	hours	total hours	type of weld	recommended thickness range (mm)	position	sketch	electrode (Ø in mm)
1	3	3	—	1)			
2	3	3 + 3 = 6	bead on plate welding	10	PA		3,2
3	6	6 + 6 = 12	fillet weld lap-joint	10	PB		3,2
4	12 (+ 3)	12 + 12 + 3 = 27	fillet weld lap-joint	10	PG		3,2
5	12 (+ 3)	27 + 12 + 3 = 42	fillet weld lap-joint	10	PD		3,2
6	15	42 + 15 = 57	—	2)			
1) introduction / familiarization 2) theoretical education E-UW 1.2							

Table 5: Practical exercises — EWF-E-UW 3

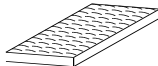
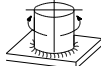
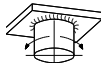
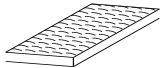
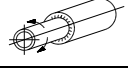
EWF-E-UW 3			Practical Exercises				
No	minimum time		Exercise				
	hours	total hours	type of weld	recommended thickness range (mm)	position	sketch	electrode (Ø in mm)
1	3	3	—	1)			
2	3	3 + 3 = 6	bead on plate welding	10	PA		3,2
3	12	6 + 12 =18	pipe fillet weld T-joint	10	PB		3,2
4	14 (+ 4)	18 + 14 + 4 = 36	pipe fillet weld T-joint	10	PG		3,2
5	15 (+ 6)	36 + 15 + 6 = 57	pipe fillet weld T-joint	10	PD		3,2
6	15	57 + 15 = 72	—	2)			
1) introduction / familiarization 2) theoretical education E-UW 1.2							

Table 6: Practical exercises — EWF-E-UW 4

EWF-E-UW 4			Practical Exercises				
No	minimum time		Exercise				
	hours	total hours	type of weld	recommended thickness range (mm)	position	sketch	electrode (Ø in mm)
1	3	3	—	1)			
2	33	3 + 3 = 6	bead on plate welding	10	PA		3,2
3	6	6 + 6 = 12	lap weld	10	PC		3,2
4	14 (+ 4)	12 + 14 + 4 = 30	lap weld	10	PG		3,2
5	17 (+ 4)	30 + 17 + 4 = 51	lap weld	10	H-L045		3,2
6	15	51 + 15 = 66	—	2)			
1) introduction / familiarization 2) theoretical education E-UW 1.2							

Section II: Examination and qualification

1 Introduction

This guideline seeks to achieve harmonization, and to set a common standard in the training examination and qualification of professional specialists in manual wet underwater welding in Europe. The national welding organizations, being members of the EWF, shall mutually acknowledge the Diploma awarded in any Member state to a diver-welder, following an examination conducted in accordance with this guideline. The “student” shall have followed this EWF special course for the Education, Examination and Qualification of a European MMA Diver Welder, and the examination shall be conducted by the national body authorized by the EWF for this purpose. This ANB will normally be the National Welding Organization, but may be another organization with the agreement of the EWF Member.

The procedure and administration is in accordance with document EWF-416 (Current edition), with additional considerations. The examination procedures (see section II, clause 2) are designed to simulate the different situations of a diver-welder active in industry. The questions are to reflect the course topics.

2 Theoretical examination

The content is given in the table 7.

Table 7: Theoretical examination — Hours

No	Examination	hours
1	Written examination as multiple choice examination	1 h
2	Oral examination (on request of examining body)	additionally
		Σ 1 h + (2) additionally

In order to pass the examination, candidates shall achieve at least 60% of the maximum possible marks in each subject.

Successfully completed individual parts of the examination shall remain valid for a period of 3 years. The examination in all four groups and optional practical part shall be completed within a period of 3 years from the start of the course.

3 Practical examination

3.1 General

During the course, all tasks of the module, listed in tables 3 to 6, have to be evaluated by the instructor. Positive evaluation of all tasks is required for the admission to the examination. For the practical examination, it is recommended that two test pieces (piece A and B) of the appropriate module given in tables 3 and 4 are to be welded and assessed by the training organization.

The test piece of the last test (piece B) shall be set aside during the period of examination for additional assessment, in case of minor deviations in test piece A.

Qualification of the diver-welder is required involving examination of the test pieces according to EN ISO 15618-1. For all test pieces appropriate a WPS according to EN ISO 15609-1 is to be issued, and given to the candidate prior to the beginning of the test welding.

The examination and qualification test shall be performed under the surveillance of ANB. The theoretical examination may be done in a written form or as a multiple choice version.

The practical examination is recommended to be carried out on the type of material and thickness category, with which the candidate will normally work. The type of material and electrode specified for the examination test pieces should be noted.

3.2 Test pieces

Test pieces are required on each welding position mentioned in the modules for practical exercise.

4 Diploma

After successful theoretical and practical examination, the Authorized National Body awards a diploma to the candidate. This diploma shall include the actual scope granted. See specific requirements when printing the EWF-diplomas in document EWF-416 (current edition).

The practical examinations of the diver-welder will be performed on the basis of EN ISO 15618-1.

ANNEX A (normative)

Requirements for Diver-Welder-Training-Schools

A.1 General

The Diver-Welder Training is a professional upgrading course strongly orientated to practical application. The theoretical basis and know-how in the welding training course is specialized in a practical as well as in a theoretical part for the qualification of an underwater welder. Therefore special requirements are necessary to be fulfilled by the Diver-Welder-Training-Schools in respect to equipment, diving facility and specially qualified instructing personnel.

A.2 Diving facilities and technical equipment

Diving facilities and technical equipment should be of a national / international recognized standard, and follow the national / international safety rules and regulations.

A.3 Qualification of instructing personnel

The Diver-Welder Training Schools have to provide the following specially-qualified instructing personnel to guarantee a substantial training and education for the trainees:

- A.3.1** Experienced Welding Supervisor (e.g. Welding-Engineer,- Technician, preferably with commercial diving background) with excellent theoretical and practical experience and knowledge in wet welding.
- A.3.2** Experienced Hyperbaric Wet Welding Instructor I/EWS or I/EWP or equivalent (experience assessed by the ANB) and commercial diver, trained and certified as a Diver-Welder according to EN ISO 15618-1 with excellent knowledge and skill, and minimum 3 years practical experience in wet welding.

ANNEX B (informative)

Abbreviations

ANB	Authorized National Body
EFW	European Federation for Welding, Joining and Cutting
MMA	Manual Metal Arc
WPS	Welding Procedure Specification
I/EWS	International/European Welding Specialist
I/EWP	International/European Welding Practitioner

ANNEX C (informative)

Bibliography

EN ISO 6947	Welds — Working positions — Definitions of angles of slope and rotation
EN ISO 9606-1	Approval testing of welders — Fusion welding — Part 1: Steels
EN ISO 15609-1	Specification and approval of welding procedures for metallic materials — Welding procedure specification — Part 1: Arc welding
EN ISO 15618-1	Approval testing of welders for under-water welding — Part 1: Diver-welders for hyperbaric wet welding
CR ISO/TR 15608	Welding — Guidelines for a metallic material grouping system
EWF-416	EWF Rules